Citation:

Maffeis C, Grezzani A, Perrone L, Del Giudice EM, Saggese G, Tatò L. Could the savory taste of snacks be a further risk factor for overweight in children? *J Pediatr Gastroenterol Nutr.* 2008 Apr;46(4):429-37.

PubMed ID: 18367957

Study Design:

Prospective cohort study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To assess the type and number of snacks consumed weekly by a large sample of 8-10-year old children, as well as to assess its relationship with body size.

Inclusion Criteria:

- Healthy children aged 8-10-years from primary schools in 3 different cities in Italy
- The protocol was in accordance with the 1975 Declaration of Helsinki as revised in 1983
- Informed consent was obtained from all of the parents.

Exclusion Criteria:

- Children diagnosed with a chronic disease along with the relevant disabilities
- Children absent from school on the day of the selection
- Children of parents who refused to participate.

Description of Study Protocol:

Recruitment : 8- to 10-year old healthy children were recruited from primary schools in 3 different cities in Italy. The study was run in the Spring of 2003.

Design : Cross-sectional study

Blinding used (if applicable): not applicable

Intervention (if applicable): not applicable

Statistical Analysis

- Student's unpaired *t* test was used to compare physical characteristics, time spent watching television and playing video games, and physical activity of the children divided into males and females.
- The Kruskal-Wallis test was used to compare these variables in males and females divided on the basis of their BMI *z* scores in 3 categories- normal weight, overweight and obese children.
- The Kruskal-Wallis test was used for the total sample size, classified as normal weight, overweight, or obese to compare the total number of servings per day, number of savory and sweet snacks servings per day, and the distribution of servings during the day.
- The Tukey test was used to perform the post hoc analysis.
- The Pearson regression coefficient was used to assess the association between variables.
- Logistical regression analysis in 2 steps. Dependent variable: body weight: classified as overweight, or obese (on the basis of the International Obesity Task Force definition) versus normal weight children (reference group).
- Step 1: sex, energy density of snacks, kind of snack (sweet or savory), and intake of soft drinks with snacks, television viewing per day, and hours spent at sports activity per week were used as independent variables. Television viewing and time devoted to the computer or playing video games correlated ($r=0.16$; $P<0.01$). Hours of sports activity per week and hours per week devoted to moderate to vigorous non programmed physical activity were correlated ($r=0.08$; $P<0.01$). Therefore, the researchers used television viewing as an index of sedentary behavior and time devoted to sports per week as an index of physical activity.
- Step 2: to adjust the odds ratio (OR) for the effect of parental obesity, the mother's and father's BMI were included among the independent variables
- All of the statistical analyses were carried out using SPSS version 13.0 software for Windows (SPSS Inc, Chicago, Il) packed for personal computers.
- Data are shown as mean (SEM).
- The probability level of $P<0.05$ was used to indicate statistical significance in all of the analyses.

Data Collection Summary:

Timing of Measurements:

The cross-sectional study was conducted in the Spring of 2003.

Dependent Variables

- Questionnaire #1 was filled out by the Pediatrician with the mother or father of each child in the recruiting area. The child's height and weight were measured and recorded at recruitment.
- Body mass index was calculated by dividing weight (kilograms) by height squared (meters) for each child. Overweight and obesity were defined using the BMI reference cutoffs proposed by the International Obesity Task Force.
- Overweight: BMI higher than the percentile corresponding to a BMI of 25 at age 18.
- Obesity: BMI higher than the percentile corresponding to a BMI of 30 at age 18.
- BMI *z* scores were also calculated according to the LMS method, using national BMI reference tables.

Independent Variables

- Number and type of snacks consumed weekly assessed by food frequency questionnaire

completed by parents

Control Variables

- Parents' BMI: self-reported parents' height and weight were also recorded. This self reported weight corresponded closely to the measured height and weight.
- Time (hours per week) devoted to sports activity: parents reported how much time their children spent in front of a viewing screen (television/video games, computers) and in sports or organized physical activity every day. The validity of parents' report of time spent in front of a video screen time was previously assessed by Anderson et al compared with videotaped observation. Parental reporting on outdoor playtime was validated by Burdette et al.

Description of Actual Data Sample:

Initial N: 1837 children (924 males, 913 females).

Attrition (final N): 1837

Age: 8-10-year olds

Ethnicity: not reported

Other relevant demographics:

Anthropometrics

Location: Pisa, Italy

Summary of Results:

Key Findings

- The children consumed on average 4 snacks per day.
- There was not statistical difference in the number of servings per day between obese and nonobese children
- Boys spent significantly more time playing video games than girls (0.8 vs. 0.4 hours/day, respectively; P<0.001), but they were more physically active than girls (4.7 vs. 3.9 hours/week, respectively, of moderate/intense physical activity; P<0.001 and 2.5 hour/week vs. 2, respectively of sports;<0.001.
- Overweight and obese girls were taller, weighed more, and had higher BMI, BMI z scores, and parents' BMI than normal-weight girls. Overweight and obese girls spent less time at sports than normal-weight girls (1.6 vs. 1.1 s. 2.2 hours/week, respectively; P<0.001). Overweight and obese girls spent more hours per week watching television than normal-weight girls (2 vs. 2.5 vs. 1.9 hours/week, respectively; P<0.001).

  The number of snack servings per day, the energy content and the macronutrients composition of snacks were not different in boys and girls.

  In further analysis, the researchers combined boys and girls in the overall comparison among children of different weight categories: normal weight, overweight or obese.

  The mean energy density was significantly different among the weight categories : 6.3

(0.08) kJ/g in normal weight , 6.8 (0.16) kJ/g in overweight, and 6.8 (0.3) kJ in obese children (P<0.005).

Obese children consumed significantly (P<0.001) more servings of soft drinks per day (2.09[0.29]) than overweight (1.08[0.1]) or normal weight children (0.96[0.05]).

Savory snack intake was significantly different in the 3 weight categories (x^2 =11.8; P=0.003) as opposed to that of sweet snacks (x^2 =5.9; p=0.05).

Overweight and obese boys were taller, weighed more, and had higher BMI, BMI Z scores, and parents' BMI than normal-weight boys. Overweight and obese boys spent less time in sports activities than normal-weight boys (2.4 vs. 1.7 vs. 2.6 hours/week, respectively; P=0.03).

Physical characteristics, time spent in front of television and video games, and physical activity of boys and girls

	Boys(n=924)	Girls(n=913)	P
Age, y	9.25(0.03)	9.24(0.03)	0.8
Weight, kg	33.7(0.29)	33.1(0.3)	0.14
Height, cm	136.6(0.3)	135.8(0.32)	0.08
BMI/kg/m^2	17.9(0.11)	17.7(0.10)	0.23
BMI z score	0.15(0.04)	0.13(0.04)	0.82
Father's BMI/kg/m^2	25.6(0.11)	25.3(0.10)	0.08
Mother's BMI/ kg/m^2	22.6(0.11)	22.5(0.11)	0.58
TV, h/day	1.9(0.03)	1.9(0.03)	0.68
Video games, h/d	0.8(0.17)	0.4(0.02)	**<0.001**
Moderate/intense physical activity, h/wk	4.7(0.03)	3.9(0.14)	**<0.001**
Sports/h/wk	2.5(0.08)	2(0.07)	**<0.001**

Data are presented as mean (SE). Bold type indicates significant results.

Parents' BMI and physical characteristics, time spent in front of television and video games, and physical activity of boys divided in normal weight, overweight, and obese.

	Normal weight(n=677)	Overweight (n=193)	Obese(n=53)	P
Age, y	9.26(0.04)	9.25(0.07)	9.2(0.14)	0.09
Weight, kg	30.6(0.22) †‡	40.2(0.48)* †	50.7(1.51) * ‡	**<0.01**
Height, cm	135.8(0.34)†‡	138.3(0.63) †	140.1(1.69) ‡	**<0.01**
BMI/kg/m^2	16.5(0.68) †‡	20.86(0.11)* †	25.65(0.37) * ‡	**<0.01**
BMI z score	-0.36(0.04) †‡	1.33(0.03)* †	2.31(0.06) * ‡	**<0.01**
Father's BMI/kg/m^2	25.2(0.12) †‡	26.1(0.27)* †	27.9(0.68) * ‡	**<0.01**
Mother's BMI/ kg/m^2	22.3(0.12) †‡	23.3(0.27)* †	24.7(0.55) * ‡	**<0.01**
TV, h/day	1.9(0.04)	1.9(0.07)	2.2(0.15)	0.06

Video games, h/d	0.8(0.03)	0.8(0.05)	0.8(0.13)	0.77
Moderate/intense physical activity, h/wk	4.9(0.21)	4.1(0.32)	4.3(0.76)	0.13
Sports/h/wk	2.6(0.09) †	2.4(0.18)	1.7(0.34) ‡	**0.03**

Data are presented as mean (SE). Tukey test, P<0.05.Bold type indicates significant results.

*Overweight vs. obese
†Normal weight vs. overweight
‡Normal weight vs. obese

Parents' BMI and physical characteristics, time spent in front of television and video games, and physical activity of girls divided in normal weight, overweight, and obese.

	Normal weight(n=677)	Overweight (n=193)	Obese(n=53)	P
Age, y	9.24(0.04)	9.33(0.07)	8.9(0.15)	0.164
Weight, kg	30.1(0.23) †‡	40.4(0.55)* †	50.2(1.8) * ‡	**<0.01**
Height, cm	134.9(0.35)†‡	138.7(0.72) †	140(1.98) ‡	**<0.01**
BMI/kg/m^2	16.4(0.07) †‡	20.8(0.11)* †	25.3(0.44) * ‡	**<0.01**
BMI z score	-0.34(0.03) †‡	1.31(0.03)* †	2.38(0.06) * ‡	**<0.01**
Father's BMI/kg/m^2	24.9(0.1) †‡	26.4(0.27) †	26.9(0.56) ‡	**<0.01**
Mother's BMI/ kg/m^2	22(0.12) †‡	23.7(0.26)* †	25.4(0.83) * ‡	**<0.01**
TV, h/day	1.9(0.04) ‡	2(0.08)	2.5(0.21) ‡	**0.005**
Video games, h/d	0.4(0.03)	0.4(0.05)	0.5(0.11)	0.36
Moderate/intense physical activity, h/wk	4(0.16)	3.8(0.4)	3.6(0.73)	0.08
Sports/h/wk	2.2(0.08) †‡	1.6(0.13) †	1.1(0.26) ‡	**<0.01**

Data are presented as mean (SE). Tukey test, P<0.05.Bold type indicates significant results.

*Overweight vs. obese
†Normal weight vs. overweight
‡Normal weight vs. obese

Number of snack servings per day, energy intake and macronutrients composition of snack servings, boys and girls

	Boys(n=924)	Girls(n=913)	P
No. of servings/day	3.9(0.08)	3.8(0.07)	0.27
Energy intake with servings, kJ/day	2603(53.5)	2516(53.1)	0.25
Protein, g/day	13(0.03)	12.6(0.3)	0.33
Protein,% total energy by snacks/day	8.3(0.01)	8.3(0.1)	0.88
Carbohydrate, g/day	98.7(2)	95.4(2)	0.23
Carbohydrate, % total energy by snacks/day	64(0.28)	64(0.28)	0.92
Fat, g/day	19.4(0.4)	18.7(0.4)	0.32

Fat, % total energy by snacks/day	27.7(0.25)	27.7(0.25)	0.88
Food quotient	0.90(0.02)	0.90(0.02)	0.91
Energy density, kJ/g	6.4(0.08)	6.5(0.08)	0.3
Savory snacks, servings/wk	8.6(0.02)	8.3(0.2)	0.5
Sweet snacks, servings/wk	7.3(0.02)	7.0(0.2)	0.2

Data are reported as mean (SE)0.5

Number of snack servings per day, and nutritional characteristics of snack servings of children divided into normal weight, overweight, and obese

	Normal weight(n=1356)	Overweight (n=387)	Obese (n=93)	P
No. of servings/day	3.9(0.06)	3.9(0.13)	4.4(0.3)	0.06
Energy intake with servings, kJ/day	2567(43)	2589(94)	2896(189)	0.15
Protein, g/day	12.8(0.2)	13(05)	14.2(1.1)	0.37
Protein,% total energy by snacks/day	8.2(0.06)	8.3(0.1)	9.2(0.3)	0.69
Carbohydrate, g/day	97.4(1.6)	97.4(3.5)	109(7)	0.15
Carbohydrate, % total energy by snacks/day	64(0.23)	63(0.46)	63(0.87)	0.46
Fat, g/day	19.1(0.36)	19.6(0.7)	21.9(1.5)	0.14
Fat, % total energy by snacks/day	27.6(0.2)	28.3(0.41)	28.7(0.2)	0.33
Food quotient	0.90(0.01)	0.90(0.01)	0.90(0.02)	0.39
Energy density, kJ/g	6.3(0.08) †	6.8(0.16) †	6.8(0.3)	**<0.05**

Author Conclusion:

In conclusion, obese children consumed more energy-dense food - especially salty food - when snacking than nonobese children. A sedentary lifestyle was associated with this behavior. The reasons for this relation are unknown. However, the influence of parents' food habits and lifestyle on those of their children is emphasized by the association between parents' obesity and their children's energy-dense food intake at snacktime, the savory taste of snacks, and sedentary

behavior. Nevertheless, adjusting for parents' BMI, the savory taste of snacks and time (hours per week) devoted to sports activity were independently associated with childhood obesity. The potential causal relationship between the preference for salty snacks and the development of obesity in children needs to be investigated further.

Reviewer Comments:

Large sample size.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes

3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	No
4.4.	Were reasons for withdrawals similar across groups?	Yes
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A

5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	N/A
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	N/A
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes

	8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
	8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
	8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
	8.6.	Was clinical significance as well as statistical significance reported?	Yes
	8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**		Yes
	9.1.	Is there a discussion of findings?	Yes
	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		Yes
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	Yes